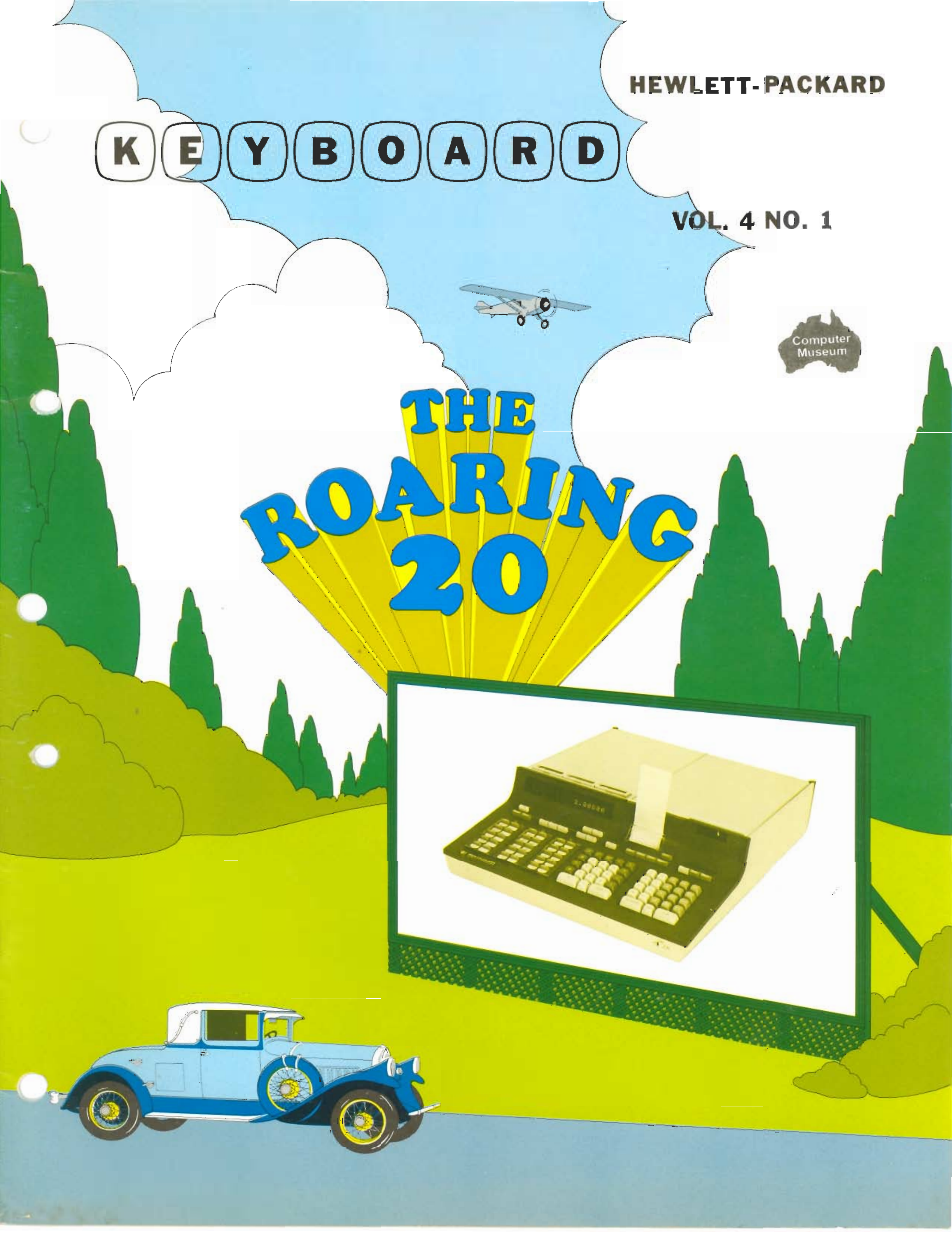
HEWLETT-PACKARD

KEYBOARD

VOL. 4 NO. 1

Computer Museum



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KEYBOARD

VOLUME 4 NUMBER 1

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TO HP KEYBOARD READERS

This issue of *KEYBOARD* features the new Model 9820A Calculator, which was introduced to the public on February 14, 1972. The Model 20 system is the result of HP's continuing effort to make available the most advanced, yet easiest to use calculating equipment.

With the popular Model 10 and now the algebraic-language Model 20 of the HP 9800 system, plus the recently announced Model 35 hand-held calculator, you have a choice of calculators to meet your specific requirements, whether for portability or programmability; for general purpose or specialized use; and for availability of predesigned programs or the utmost ease of writing your own programs.

KEYBOARD will continue to support users of all of the HP calculator line, including both the 9100 and 9800 series, with programs, programming tips, articles, and information on programs added to the catalog.

We welcome your suggestions on how to make *KEYBOARD* more useful to you. Any programs or programming tips you feel are of general interest will be evaluated for possible publication in *KEYBOARD*, or in a program library, or listing in the Calculator Program Catalog.

NEW FIELD EDITOR

Jerry Reinker of the Hewlett-Packard office in Dayton, Ohio, is now the *KEYBOARD* field editor for the U.S.A. Midwest Sales Region. He will be glad to receive your programs and programming tips from that area for evaluation, or communications concerning *KEYBOARD*.

Your comments regarding types of articles and information you would like to see in *KEYBOARD* will be welcomed by any member of the editorial staff.

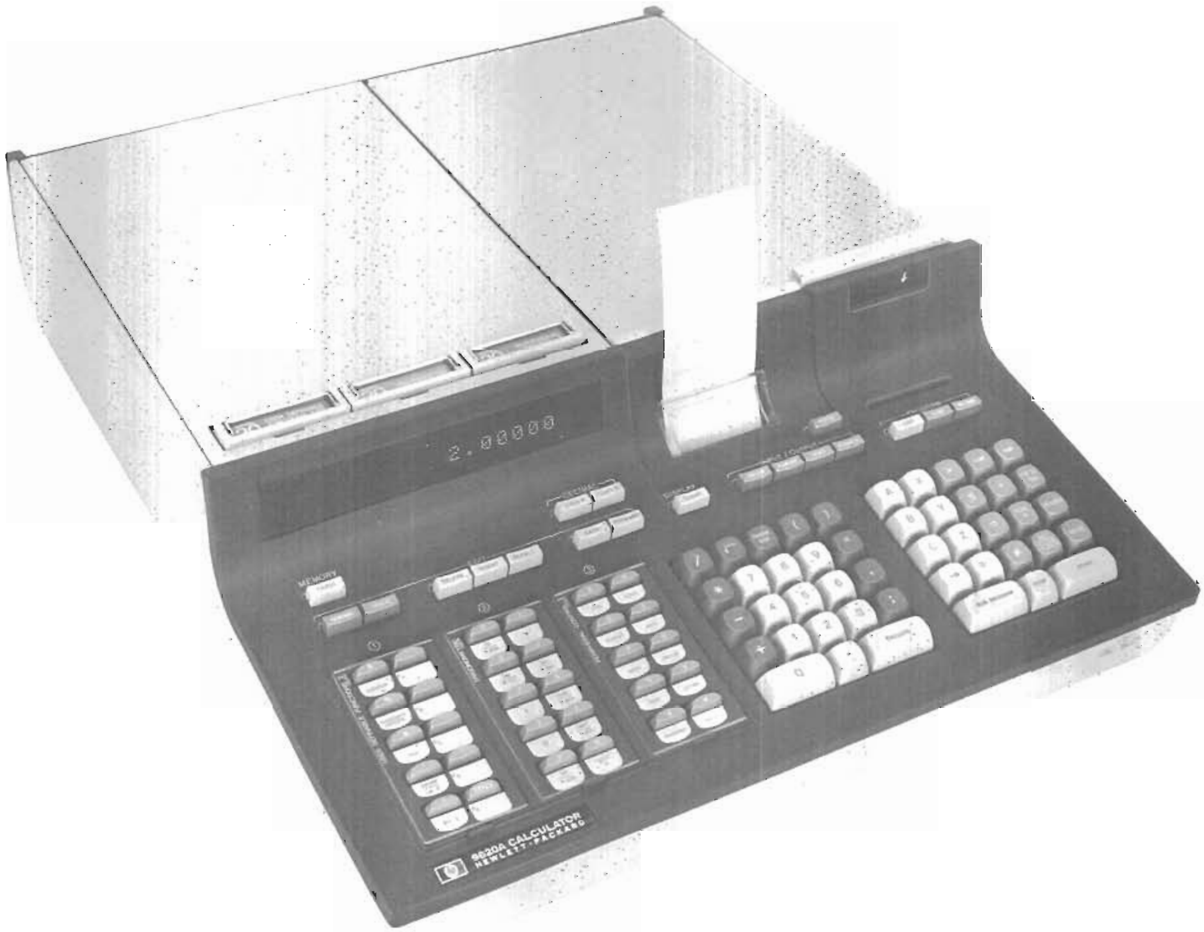
CAN YOU TOP THIS?

Norway recently reclaimed the record for the most northern sale of an HP calculator. This was reported to us by Jacob Odland of the Hewlett-Packard Oslo sales office. The customer who recently purchased a Model 10 Calculator is Narvik Technical College, located at 68.4 degrees, or 207 kilometers above the Arctic Circle.

MEET THE HP SERIES 9800

MODEL 20

Computer Museum



ALGEBRAIC PROGRAMMABLE CALCULATOR

New concepts in programmable calculator design make the Hewlett-Packard Model 9820A (Model 20) extremely easy to use, program, and edit, as well as highly versatile. Using an easy algebraic language, the Model 20 allows you to simply enter arithmetic and algebraic problems on the keyboard the same as you would write them on paper to obtain fast, accurate solutions.

The Model 20 allows you to design your own personal computing system. With a choice of internal memory sizes, several plug-in blocks to define up to three key-banks with your selection of functions, and a variety of input and output peripherals, you can specify and purchase only the capabilities you need for your present applications. If your needs increase in the future, the Model 20 system can be quickly expanded to meet them, right in your own office.

As an example of the Model 20's computing power, the basic memory is sufficient to solve 17 simultaneous linear equations in 17 unknowns, and the 429-register optional memory can solve up to 36 equations in 36 unknowns.

Six major features of the Model 20 Calculator contribute most of its computing power, ease of use, and versatility. These are its:

- Natural algebraic language
- Simple programming and editing
- Three special function key banks
- Full alphanumeric display and built-in printer
- Expandability through plug-in blocks, memory, and peripherals
- Magnetic card reader

NATURAL ALGEBRAIC LANGUAGE

The Model 20 uses a powerful but natural instruction set which combines the best features of the conventional programmable calculator keyboard language with some of the best features of computer languages like FORTRAN or BASIC. It includes branching and sub-routining, as well as adding many of its own unique features. As a result, the Model 20 uses a language with the same symbols and structure as algebra. It provides a human-oriented, conversational approach to problem solving.

Since the basic calculator's complete alphanumeric capability also appears in the built-in printer and the display, programs can include printed or displayed user instructions, as well as alpha labels for input data and results.

The structural unit of the Model 20 language is a *line* composed of one or more *statements* representing complete activities. Statements are separated by semicolons. Maximum line length can be from 35 to about 68 keystrokes. Here is an example of a line:

```
                    STATEMENTS
21:  PRT 3AB/(.5C-Y)→X;SPC 3
LINE NO.             LINE
```

In this line, A, B, C, and Y are the contents of the indicated registers. The first statement prints the calculated numerical value of the expression $\frac{3\,AB}{.5C-Y}$ and also places this value in the X storage register. The second statement causes the printer to space three lines after the activity specified by the first statement has been completed. Note that in this line no multiplication instruction is needed, since the Model 20 performs implied multiplication automatically.

You can either execute a line or store it. Pressing EXECUTE when there is a line in the display is keyboard operation. This causes all of the operations specified in the line to be performed, and the results to be displayed, printed, or stored, as instructed by the line statements.

SIMPLE PROGRAMMING AND EDITING

A program is composed of a series of lines which perform activities in a logical sequence. To place a line in the read/write memory as a program line, you merely press STORE. The lines are automatically assigned sequential numbers (0, 1, 2, . . . n) as they are stored.

The Model 20 provides unprecedented ease of programming and program editing. Some of the unique features helping to attain this ease are discussed here.

A NOTE (N) appears in the display immediately when a language syntax error occurs, referring to a table identifying the type of error. For example, omitting a closing parenthesis causes NOTE 03 to appear. Pressing BACK replaces the line in the display, so that you can insert the missing parenthesis and continue entering additional characters.

To help in editing or verifying a program you can obtain a listing such as the one shown below at the touch of a key. You can list either the entire program or any selected part of it. The listing serves as a permenent file record, as well as an editing aid.

```
0:
FXD 3;ENT "ALPHA
",A,"LOAD RESIST
ANCE",B,"INPUT R
ESISTANCE",C⊢
1:
PRT (A/(1-A));(A/
(1-A))B/C⊢
2:
GTO 0⊢
3:
END ⊢
R392
```

PROGRAM LISTING

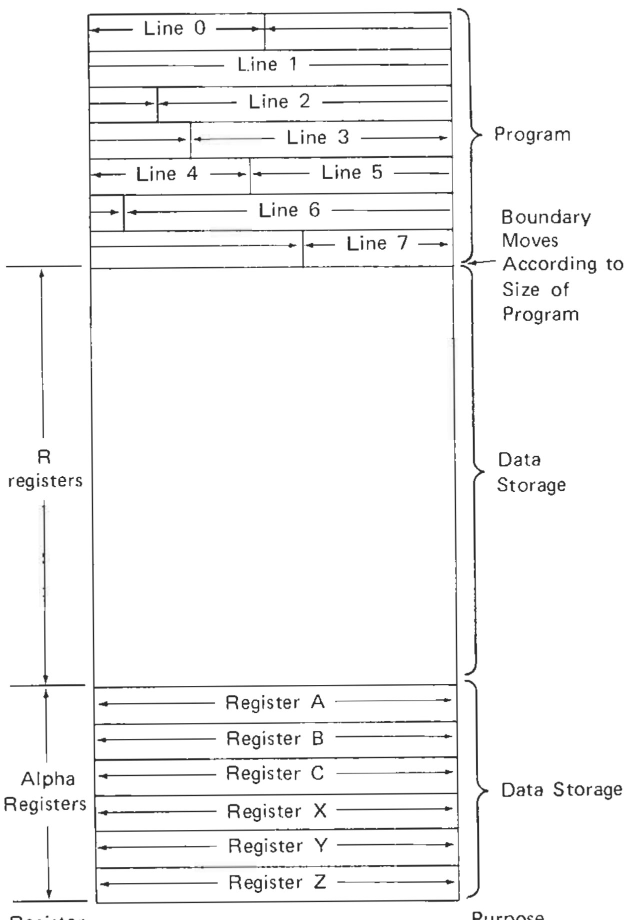
In the TRACE mode, the Model 20 prints each line of the program as it is being stored: or during program execution, it lists the number of each line and any quantities it stores, as shown below. This helps you verify intermediate results and detect logic errors.

```
0:
0.985→A⊢
              .985
4950→B⊢
          4950.000
5050→C⊢
          5050.000
1:
          4226.723
2:
```

TRACE MODE PRINTOUT FROM PROGRAM ABOVE

The TRACE mode is an excellent tool in debugging programs. You can select it either from the keyboard or by a program statement to examine part of the program's activity, then cancel it with a NORMAL statement following the suspected part of the program.

For most efficient use of the read/write memory, the Model 20 stores program lines sequentially without gaps. It also allows additions, insertions, and corrections to be made simply. Whenever an additional character, statement or line is inserted, or one is deleted, the balance of the program adjusts to occupy the minimum required memory, and lines are automatically renumbered if required.



THE MODEL 20 MEMORY

You can add a line to a program simply by addressing the line number, entering the line through the keyboard, and pressing [INSERT] [STORE].

Similarly, you delete a line by addressing the line number and pressing [RECALL] [DELETE]. This avoids any need for rerecording or rekeying large sections of a program to make corrections.

You can add, change, or delete program statements or characters (a character results from each keystroke) using the editing keys. Recall the line to the display. Then simply back space to the position of the character to be changed, make the change and restore the modified line.

The Model 20 includes powerful branching capability. Branching can be unconditional, with a GO TO instruction, or conditional, dependent upon numeric or FLAG status. The target branching address can be a specific line number, a relative line number, or a label independent of line numbers. Some examples of branching statements are shown below.

`GTO 10` is an unconditional statement which will cause the program to branch to line 10, a specific address.

`GTO +5` or `GTO -4` will cause branching ahead five lines or back four lines.

`IF A=0;GTO "DOT"` is a conditional statement causing branching to the label address "DOT" if the condition A = 0 is met; otherwise the program ignores the rest of that program line and proceeds with the next sequential line.

`IF FLG 0; JMP (A+2B)` will cause jumping ahead or back the computed number of lines if Flag 0 is set; otherwise the program proceeds with the next line.

A logical statement such as A = 0 will be assigned a value of 0 if the statement is false, or 1 if the statement is true. In addition to being a powerful branching tool, this boolean capability has many other uses. For instance, a step function can be specified over the range

$$Y = 6 \text{ for } X \leqslant 100$$
$$Y = 21 \text{ for } X > 100$$

in one expression by

`(X≤100)6+(X>100)21→Y`

Subroutines can be nested up to 30 deep, adding greatly to the calculator's power.

The Model 20 has 16 flags. Any flag can be set or cleared either from the keyboard or by a program statement.

Looking at the memory map, you will see that data storage, other than in the dedicated Alpha registers, is in the available R ( ) registers (R0, R1, . . .). The R-register address can be computed, such as R(A + B/2 – 4), or it can be nested, such as R(R(R(R 24))), for indirect addressing. Nesting can be to any depth within the allowable program line length.

THREE SPECIAL FUNCTION KEY BANKS

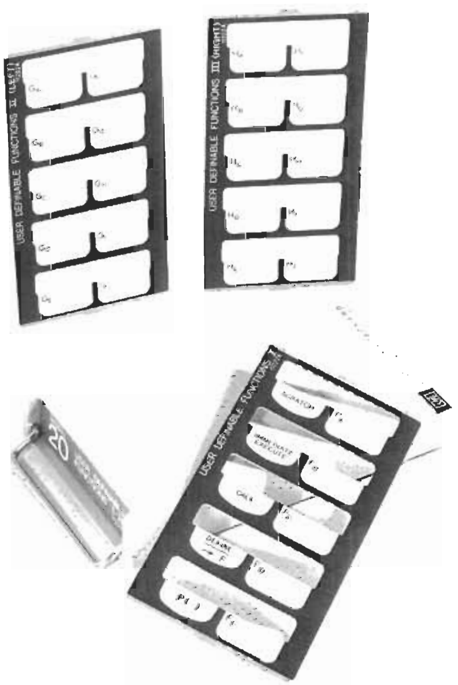
Up to three 10-key keybanks of the Model 20 can be assigned special functions by plugging a powerful read-only-memory (ROM) block into one of the numbered slots in the top of the calculator. An overlay marked with the special functions assigned to each key snaps into place over the proper key bank.

Three plug-in blocks are now available.

The Model 11220A *Peripheral Control I* block provides general-purpose control of most Model 20 peripherals. It is especially powerful in controlling the Model 9862A Plotter and the Model 9861A Typewriter. With the plotter, the Model 11220A allows scaling of your problem in *user units*, plotting axes with tic marks, and labeling with words and numbers. With the typewriter, you can choose either a four-column format with the simplest command set, or a fully-formatted output allowing typing of standard forms, tables, and letters.

The Peripheral Control I block also includes READ, WRITE, and TRANSFER statements to facilitate data input, output, and transfer among peripherals in a Model 20-based system.

The Model 11221A *Mathematics* block provides mathematical functions such as sine, cosine, tangent, log x, ln x and inverses of these functions. It also allows you to raise a number or expression to a non-integer power, and to set your arguments to degrees, radians, or grads. In addition, it gives the value of pi in one keystroke. Also provided are the integer part and absolute value of a given number.



The Model 11222A *User Definable Functions* block allows you to define up to 25 of the keys in the left-hand keyblocks with special functions and subprograms. With no other blocks in place, 15 keys are available. Five keys can be defined if all the plug-in slots are filled.

All subprograms are stored in a protected part of the memory, so they cannot be changed accidentally while mainline programs are being edited or stored.

Three types of subprograms can be used with the Model 11222A:

Immediate Execute routines or functions are available at a touch of the definable key. These routines may be any programs solving your repetitive problems, such as impedance, loan interest, economic order quantity, and many others. They have the advantage of not requiring any skill on the user's part; they are instantly accessible, independent programs.

Subroutines with parameters are those normally called by the mainline program several times in the solution of a problem, but with different input quantities involved each time. The subroutine is written in terms of unknown parameters P1, P2, P3 . . . These parameters are assigned specific values by the main program, including the values of algebraic expressions, whenever the subroutine is called. An example of passing parameters, as this process is called, is shown below.

```
0:
"HYP "⊢
1:
r(P1P1+P2P2)→P3⊢
2:
END ⊢
R393
```

SUBROUTINE WITH PARAMETERS

```
0:
FXD 0;ENT A,B⊢
1:
CLL HYP A,B,C⊢
2:
PRT A,B,C;SPC 2⊢
3:
END ⊢
R393
```

MAINLINE PROGRAM USING SUBROUTINE

You can assign a name or mnemonic to your subroutine, such as N! to identify it in mainline program listings or displays.

Defined functions may also use parameters, as in the N! function below. A defined function is used in the same way as a key in the basic calculator, such as (√‾). Note in the N! example that the defined function mnemonic appears in the program just as it would be used in a mathematical expression on paper.

```
0:
"N!";P1→P2;1→P3⊢
1:
IF P2=0;P3→F ;
GTO 3⊢
2:
P2P3→P3;P2-1→P2;
GTO 1⊢
3:
END ⊢
R383
```

N! AS A DEFINED FUNCTION

```
0:
ENT "N",A,"K",B⊢
1:
N!A/N!BN!(A-B)→C
⊢
2:
FXD 0;SPC 2;PRT
"N=",A,"K=",B,"C
=",C⊢
3:
END ⊢
R383
```

COMBINATION PROGRAM

The combinations program calls N! three times in each solution with different parameter values, saving considerable memory space.

Although any of the plug-in blocks can be placed in any slot in the Model 20, all programs written by Hewlett-Packard use this configuration:

Definable Function Block	Slot No. 1 (left)
Mathematics Block	Slot No. 2 (center)
Peripheral Control I Block	Slot No. 3 (right)

Users are encouraged to employ this same configuration for consistency. The slot for any unused plug-in unit is left empty.

ALPHANUMERIC DISPLAY

Because of the Model 20's alphanumeric output algebraic language, only a single display is required. This uses light-emitting diodes in a 16-character display, which is easy to read over a wide range of angles and distances. Each of the 9/32 inch (1,43 cm) high characters uses a 7 x 5 dot matrix of light-emitting diodes to provide naturally-shaped numbers, letters, and symbols in this size:

π√(AA+BB)→Z

ALPHANUMERIC PRINTER

A quiet, thermal printer is built into the basic Model 20 Calculator at no additional cost to provide permanent records of programs and data. It can print the same numbers, symbols, and letters that are displayed, as well as user instructions, alpha labels for program results, and other alphanumeric messages.

The maximum printer and display line length is 16 spaces. However, this does not limit the program line length, which can be from about 35 to 68 keystrokes, depending on its composition.

PERIPHERAL AND MEMORY EXPANDABILITY

The Model 20 is expandable through plug-in ROM's, added internal memory, and external peripherals, providing capabilities to match any type of application. The basic calculator has 173 R ( ) registers (see memory map). A 429-register memory can be supplied in lieu of this, either with the original shipment (Option 001), or installed later (Model 11228A) by any HP service personnel.

The Model 20 accepts up to four peripherals at one time, allowing you to assemble a personalized system for your particular applications. An input/output expander to be introduced soon will allow the use of all peripherals simultaneously. The peripherals now available are:

- Model 9860A Marked Card Reader
- Model 9861A Typewriter Output
- Model 9862A Plotter
- Model 9863A Paper Tape Reader
- Model 9864A Digitizer
- Model 9865A Tape Cassette
- Model 2570A Coupler/Controller
- Model 2575A Coupler/Controller

BUILT-IN MAGNETIC CARD READER

The magnetic card reader built into the basic Model 20 allows you to make and reuse permanent recordings of programs and data. Two sizes of cards, 6 inches (15,2 cm) long and 10-1/2 inches (26,7 cm) long, are available. The cards designed for the Model 9100A/B can also be used for short routines.

After you have finalized and recorded your programs on magnetic cards, you can easily protect them against accidental rerecording by removing a perforated tab at each end of the card.

OTHER FEATURES

You can specify the format of numbers to be displayed and printed, as either fixed point or floating point, with any number of digits up to 9 to the right of the decimal point. The commands are given either in a program or from the keyboard. The last displayed digit is automatically rounded. For example, 705.51554 may appear in one of these sample formats:

FIXED (3)	705.516
FLOAT (9)	7.055155400E 02
FLOAT (3)	7.055E 02

The Model 20 handles any number in the range $-9.99999999999 \times 10^{99}$ to -10^{-99} 0, and $+10^{-99}$ to $+9.99999999999 \times 10^{99}$ with 12 significant digits. The ten most significant digits are displayed; the other two are guard digits, which prevent rounding errors.

In addition to the 173 or 429 R ( ) registers, the Model 20 has six built-in, dedicated data registers. These six registers, A,B,C,X,Y, and Z, have their own keys. The Z-register performs the special function of automatically storing the numerical result of executing a line if no other storage register is designated.

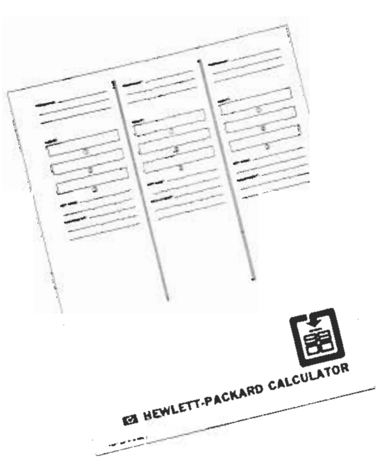
The Model 20 keyboard is human engineered. It has fingertip-fitting keys, which are functionally grouped, as well as color coded. Often-used keys such as RUN PROGRAM, 0 and EXECUTE are oversize for convenience. Half-size keys in the three left-hand key banks allow room for overlays to label their special functions assigned by the plug-in blocks.

MATHEMATICS PROGRAM LIBRARY

A library of powerful mathematics programs (Model 20 Math Pac, Part No. 09820-70000) is supplied with each Model 9820A Calculator. It contains 26 programs which will solve about 60 types of mathematics problems. A list of the programs is given in this *KEYBOARD*, as well as a representative program.

For a demonstration of the new algebraic calculator, contact the Hewlett-Packard sales office in your area, or fill out and mail the reply card in this issue.

NEW MAGNETIC CARDS AND CARD HOLDERS



The new 10 1/2" (26,67 cm) magnetic cards for the Model 20 are available through your Hewlett-Packard sales office. The part number is 9162-0045. These cards are interchangeable with the 6" (15,24 cm) cards for use with the Model 10 as well, and hold more program steps per side.

The magnetic card holder shown is designed to hold either the 10 1/2" or 6" cards. This is designed to fit into a three-hole ring binder, and is 11" (27,9 cm) high by 8 1/2" (21,6 cm) wide. The card holder, Part No. 9230-0052, can be obtained through your local Hewlett-Packard sales office.

The first data processing systems were extremely large and expensive. As the years passed, they have become smaller and more popular. The opposite end of the computing spectrum has experienced a similar type of technological growth. Mechanical adding machines are giving way to electronic devices. Mechanical calculators have almost completely gone electronic, enabling them to include previously unheard-of capability. The HP-9100A, with its "human engineered" design, is an example of an excellent marriage between calculator and electronics.

There are indications that the market for such devices will continue to grow. Unfortunately, the only people who can take advantage of this advance in modern technology are those who have both the need and the financial resources. It was felt that many people would like to use a small desk-top computer, if one were made available to them.

The author had the opportunity to use an HP 9100A in conjunction with a project. After its completion, additional applications were found which could have easily been handled on the HP 9100A, if one were available. This led to the formation of Computer Rental Service (CRS) and the concept of the Nation's first self-service, coin-operated electronic digital computer.

THE NATION'S FIRST COIN-OPERATED COMPUTER

by J. Bradley Flippin

The HP 9100A was selected as the ideal computer for this application for several reasons: It is a respected name, the keyboard is easy to use and read, it is ruggedly constructed, it has a quiet CRT display with three visible registers, and it is easy to program and operate. An HP 9160A Marked Card Reader provides the user with a rapid means of entering programs, and repetitive and pre-formatted data.

The first installation was made June 16, 1971 in the Monterey City Library in Monterey, California, a community of about 27,000. Miss Davis McDaniel, the head librarian, feels a library should be more than a simple repository of books; it should provide its patrons with "education, recreation, information, and experience." "We already had a microfilm reader/printer and a coin-operated copy machine," said Miss McDaniel. "The coin-operated computer is simply an extension of the informational services we offer. We are a modern and progressive library and the computer was a new idea which seemed to fit our overall objectives, so we were willing to try it out."

The library, in turn, provides an atmosphere conducive to study and suitable for the serious user. The library is ideally situated, with the city's high school across the street and Monterey Peninsula College (MPC), the local junior college, only a mile away. The largest percentage of the users are students, many of them from MPC, even though it has an IBM 1620 installation. Some of the students say they like getting instant turnaround time, not having to learn programming language, and not being plagued by the system being "down" when they want to use it. The surveying class has found the installation very useful. They can obtain their field data, then use the coin-operated computer to check it for closure, area, and coordinate points prior to concluding the day's work. Other users include several individuals who are conducting statistical studies relating to their quality control functions where they work.

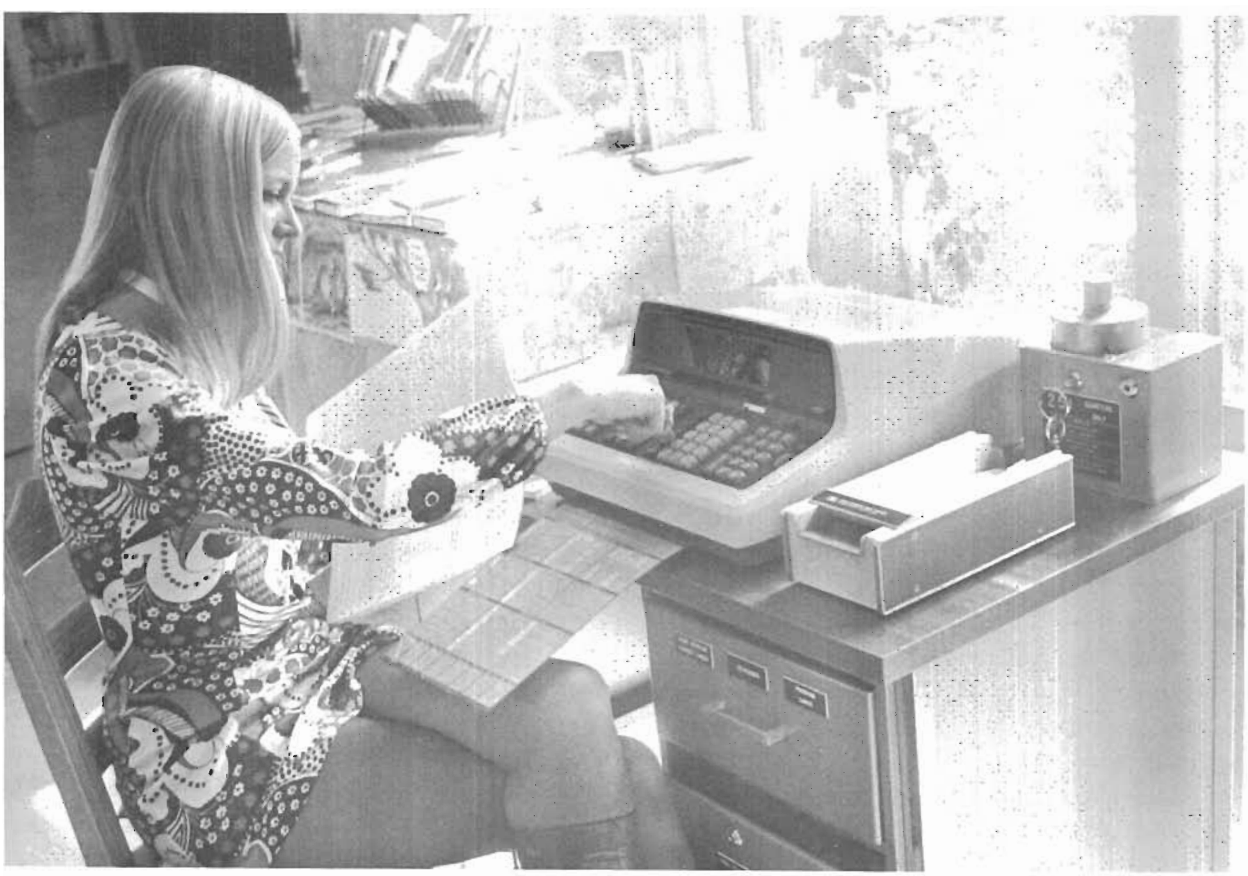
Unfortunately, there is no feedback on the types of programs the other users are running. Users are advised they can call CRS anytime for free help and programming assistance, but there have been few calls. Those the author has talked with all seem to have the "I'd rather do it myself" attitude. The challenge of learning themselves, from the manuals and the specially prepared supplemental materials, is evidently part of the attraction.

The installation itself is complete in every detail. A full set of manuals is supplied, including copies of current HP 9100A literature. Also included are quantities of Program and Surveying Cards for the Marked Card Reader, a special pocket sized keycode reference card which the users can keep, and postpaid user opinion survey cards for their comments regarding the installation. Arrangements were also made with a local office supply store only two blocks from the library to handle a line of manuals and supplies, including the magnetic program cards (the only item not provided free to the users). This provides the serious user with a local source of personal reference material.

People generally do not believe there really is a computer in their library. Their reactions tend to fall into two general categories: either they think it is an educational device which simulates a computer as part of an exhibit, or they think the library has installed a large data processing system to keep track of the books and they have idle time which they are renting. As a result, they are not interested in using a toy nor are they interested in getting involved with a large system which might require learning a special language.

Demonstrations are held periodically in an effort to combat these misconceptions. This allows potential users to see the system operate and use it themselves. As a result they find it is, in fact, very easy to use. Those without any mathematical background are astounded by the speed and the capability of the HP 9100A. Some are convinced it is connected to a big computer, and they look around for the rest of the "system".

Computer Museum



Although the results of the tests are not yet complete, it appears that the systems are suitable for installation in high school libraries, junior college libraries, where there is not an extensive data processing capability, and in libraries of middle and large sized communities, particularly those with some technically oriented industries.

Systems can be installed in several different ways. In the case of the Monterey City Library, the unit was installed as a concession. This has the advantage of providing the students and the citizens with a self-service computer for their use, and does it without any burden on the taxpayers. This is important because many schools would like to have this capability but find their budget is sometimes barely enough to cover essentials. Other methods include leasing and purchasing. Under these programs the schools would receive 100% of the gross coin revenue which could then be used toward the cost of the installation. A side advantage of the coin-operated computer lies in its easy accessibility in the school's library. Usually the school budget is broken down by department. If a computer were purchased, it would probably be with one department's funds, in which case it would most likely be installed in that department's area and would not be as easily accessible to other students as one located in the library.

Monterey was not the ideal place in which to undertake such an innovative concept, as it is generally considered to be a small retirement community whose main industry is tourism. It can be said, however, that installation has proved there is a need for such a service. Current plans call for continuation of the testing program and leaving the unit in the Monterey City Library as long as they will have it. Additional installations are planned in the California area as soon as arrangements can be made with interested schools and libraries.

Although the publicity the installation has received has been rather sparse in the local area, it has received national publicity and has been mentioned in many national computer magazines. An NBC news team even filmed a sequence about it, and a vending industry, a college business magazine, and a national library journal are in the process of preparing articles about the installation. The biggest surprise came when a telephone call was received from an editor of a computer magazine in London, England.

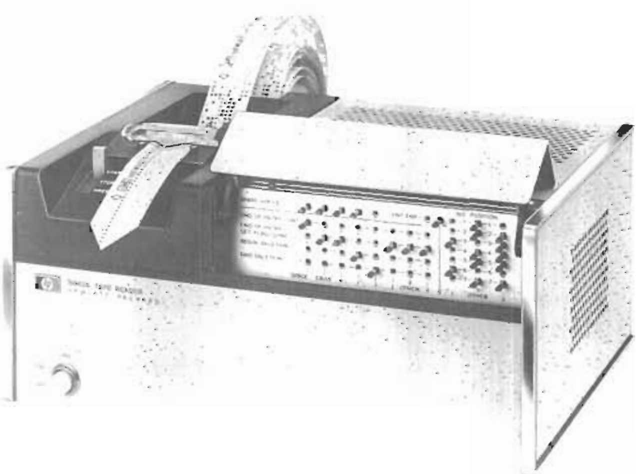
The author wants to take this opportunity to thank Hewlett-Packard representatives as they have been a big help in providing software and suggestions along the way. The author was previously aware of the excellent service support that went with the HP name. This project has further substantiated this fact and is one of the reasons HP equipment was and will probably continue to be selected for use in future installations. ■

Brad Flippin is an Electronic Engineer, having been graduated from California State Polytechnic College's San Luis Obispo Campus in 1958. He has always been interested in miscellaneous ventures in the areas of electronics and data processing. He started San Diego's first commercial IBM 1401 computer programming classes in 1963.

Mr. Flippin was a test engineer on the MINUTEMAN system at Autonetics in Downey, prior to going to San Diego where he became the Chief Project Engineer of WAVELABS, a small electronic company. While in San Diego he did some graduate work at San Diego State in the field of Business Administration. He is currently working in the Monterey area where in May 1971, he formed the Computer Rental Service, a small organization specializing in coin-operated computing systems.

Computer Museum

FAST INFORMATION INPUT FOR THE 9800 SYSTEM



Many measuring devices output data onto punched paper tape for further data reduction with computers or calculators. Provided the computing device has a means of reading punched paper tape, data transfer becomes fast and convenient at a much lower rate of erroneous data entries. Hence the 9863A Tape Reader has been developed for the HP 9800 Calculator series.

The new HP Model 9863A Tape Reader (Model 63) allows full control of both data and program storage for 8-level ASCII/ISO coded punched paper tape (optional any 5- or 8- level code). The Model 63 can be manually set either to DATA or NORMAL mode. In DATA mode, numerical data are entered into the calculator for immediate computation or for transfer to other peripherals such as the HP 9865A Tape Cassette. In NORMAL mode, the ASCII/ISO characters of the tape are interpreted as program instructions and allow full control of the calculator from the tape. In either mode the Model 63 can read as many as 20 characters per second.

OPERATION

1. Data Mode

A calculator command initiates the data reading. The reading is terminated by an "End of Entry" character on the tape. This character (called a "delimiter") can be any ASCII/ISO character, and is easily selected via a convenient patchboard located behind an access door in the front of the unit. A second delimiter can be used after the data entry to set an interval FLAG in the calculator. In order to obtain maximum flexibility, the Model 63 does not only recognize the first delimiter after a numerical character on the tape, but is set in a waiting position to read a second delimiter.

The Model 63 can also be programmed to ignore certain specified areas of the tape. A "Begin Deletion" character on the tape tells the Model 63 to continue reading, but to ignore all data on the tape until an "End Deletion" character is encountered. Both "Begin Deletion" and "End Deletion" can be any ASCII/ISO character.

Programming either the letter "E" or any other ASCII/ISO character allows the numerical data following this character to be read into the calculator as an exponent to the base 10.

2. Normal Mode

An ASCII/ISO character has been assigned to each key of the series 9800 Calculators. ASCII/ISO characters which are not assigned to the keyboard are ignored during the reading process. Depending upon the instructions on the tape, a sequence of keystrokes will either be stored in the calculator's program memory or executed in the sequence they are read.

Upon recognizing a delimiting character the Model 63 stops reading. The rest of the patchboard is disabled in the NORMAL mode.

SPECIFICATIONS

Speed:	20 characters per second
Code:	8-level ASCII/ISO code (optional any 5- or 8-level code)
Tape:	The tape is 1 inch (2,54 cm) wide.
Temperature Operating Range:	0°C - 45°C.
Weight:	Net 8.8 lb. (4 kg)
Power:	115 or 230 V + 10%, - 22% 48 to 440 HZ, 39 VA max.
Dimensions:	5.5" (14 cm) long 11" (28 cm) wide 8" (20,3 cm) deep

DEMONSTRATIONS

Demonstrations of the new Model 9863A Tape Reader may be arranged by contacting any Hewlett-Packard sales office.

MODEL 20 MATH PAC

The Model 20 Math pac, Part Number 09820-70000, is a volume of 26 practical mathematics programs for solution by the new algebraic calculator. One copy of this 177-page library is supplied with the shipment of each Model 20. The book is also available separately, as well as complete sets of prerecorded magnetic cards.

A listing of the programs is shown below.

Section I MATRICES AND LINEAR EQUATIONS

1. Real Matrix Arithmetic
2. Complex Matrix Arithmetic
3. Real Matrix Inversion, $N \leqslant 9$ or $N \leqslant 18$
4. Complex Matrix Inversion, $N \leqslant 5$ or $N \leqslant 12$
5. N Simultaneous Linear Equations with Real Coefficients in N Unknowns, $N \leqslant 9$, $N \leqslant 18$
6. N Simultaneous Linear Equations with Real Coefficients in N unknowns, $N \leqslant 17$, $N \leqslant 36$
7. N Simultaneous Linear Equations with Complex Coefficients in N Unknowns, $N \leqslant 4$, $N \leqslant 11$
8. Characteristic Equation
9. Eigenvalues of a Matrix with Real Entries

Section II POLYNOMIALS

1. Polynomial Arithmetic
2. Polynomial Root Finder
3. Polynomial Evaluation, Normalization, or Construction
4. Polynomial Integration, Differentiation, or Origin Shift

Section III INTEGRATION AND ANALYSIS

1. Simultaneous Ordinary Differential Equations, Runge-Kutta (Gill Method)
2. Romberg Quadrature for $\int_a^b f(x)\,dx$
3. Gaussian Quadrature for $\int_a^b f(x)\,dx$ or $\int_a^\infty f(x)\,dx$
4. Numerical Integration with Equally Spaced Base Points, Newton-Cotes Closed Formulas
5. Numerical Integration with Unequally Spaced Base Points, Interpolation, First and Second Derivatives, and Curve Through Points Using Spline Functions
6. Curve Fitting by Chebyshev Polynomials
7. General Function Plot
8. Lagrange Interpolation for Unequally Spaced Data
9. Fourier Series Coefficients for Unequally Spaced Data
10. Partial Sum of an Infinite Series/Partial Product of an Infinite Product
11. Roots of $F(X) = 0$ in an Interval

Section IV SPECIAL FUNCTIONS

1. Bessel Functions I
2. Bessel Functions II

MODEL 10 STAT PAC VOL. 2

An additional volume of statistics programs is now available for use with the Model 10 Calculator. This collection, Stat Pac Vol. 2, is a selection of highly sophisticated programs developed by the Statistics Laboratory of Colorado State University. As the program listing indicates, emphasis has been placed on *Analysis of Variance* and *Regression Analysis*. All programs give complete solutions and (where applicable) include "error correcting" options. This *KEYBOARD* contains a program from Model 10 Stat Pac Vol. 2, Polynomial Regression ($K \leqslant 10$, with plot and plotter control block), which illustrates a typical program, in data input, output, and completeness.

PROGRAM LISTING

Section I – Analysis of Variance

1. One Way AOV with Bartlett's Test
2. Two Way AOV with Replicates ($r \leqslant 30$)
3. Two Way AOV with Tukey Test for Interaction
4. One Way Analysis of Covariance (Treatments $\leqslant 22$)
5. Latin Square Analysis ($t \leqslant 14$)
6. Nested Classification – 3 Stage

Section II – Regression Analysis

1. Polynomial Regression ($k \leqslant 5$, with plot)
2. Polynomial Regression ($k \leqslant 5$, with plot–plotter control block)
3. Polynomial Regression ($k \leqslant 10$, with plot–plotter control block)
4. Multiple Linear Regression (no. of independent variables $\leqslant 6$)
5. Multiple Linear Regression (no. of independent variables $\leqslant 11$)

Section III – Miscellaneous

1. $(r \times c)\chi^2$ Contingency Table ($r \leqslant 9$) ($c \leqslant 10$)
2. $\bar{x}$ and R Control Chart (with plot)

Model 10 Stat Pac Vol. 2 is available through your local HP sales office.

FOURIER SERIES COEFFICIENTS FOR UNEQUALLY SPACED DATA POINTS

This program calculates the Fourier Series coefficients a_n and b_n that represent a periodic time function f(t) represented by discrete x, y pairs of data points over a period T. The x coordinate values have to be entered in ascending order but need not be equally spaced. The Fourier Series representation of f(t) is:

$$f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos \frac{2\pi nt}{T} + b_n \sin \frac{2\pi nt}{T}$$

where

$$a_0 = \frac{1}{T} \int_{t_0}^{t_0+T} f(t)dt$$

$$a_n = \frac{2}{T} \int_{t_0}^{t_0+T} f(t) \cos \frac{2\pi nt}{T} dt \qquad n = 1, 2, 3, \ldots$$

$$b_n = \frac{2}{T} \int_{t_0}^{t_0+T} f(t) \sin \frac{2\pi nt}{T} dt \qquad n = 1, 2, 3, \ldots$$

The program evaluates the coefficients by numerically integrating using a parabolic fit through each grouping of three consecutive points. Execution time is dependent upon the number of pairs of data points and the number of coefficients desired. Also, if n denotes the highest coefficients a_n, b_n desired and k the number of data pairs, problem size is subject to the constraint $n + k \leqslant 116$ (or $\leqslant 113$ if the Peripheral Control I block is in the calculator). For example, 100 data pairs could be entered and 16 values of a_n and b_n obtained.

The equipment required includes the 429-register internal memory (Option 001) and Model 11221A Mathematics block. For plotting, Model 11220A Peripheral Control I block and Model 9862A Plotter are also required.

If a plotter is available, the General Function Plot program, III-7, may be used in conjunction with this program to produce an approximating Fourier Series plot, an f(t) frequency spectrum plot, and a phase spectrum of f(t) plot.

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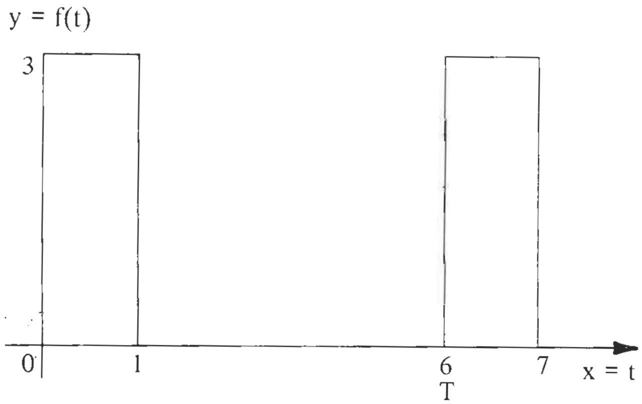
Editor's Note: The complete program is contained in the Model 20 MATH PAC, Part No. 09820-70000, a copy of which is supplied free with shipment of each Model 9820A Calculator. Prerecorded magnetic cards are available in complete sets only, Part No. 09829-70000.

EXAMPLE



INPUT DATA

Using the x, y pairs below selected from the above rectangular wave form, find the first 10 values of a_n and b_n of the Fourier Series representing this wave form.

(Note: If plotting is to be done, be sure to insert the Peripheral Control I block in slot No. 3 prior to Step 1 in the User Instructions).

Final n = 10

x	y	x	y	x	y	x	y
0	1.5	.8	3	2.5	0	5	0
.1	3	.9	3	2.75	0	5.2	0
.15	3	1	1.5	3	0	5.4	0
.2	3	1.1	0	3.5	0	5.8	0
.25	3	1.2	0	3.7	0	5.85	0
.3	3	1.3	0	3.9	0	5.9	0
.4	3	1.5	0	4	0	6	1.5
.5	3	1.7	0	4.25	0		
.6	3	1.9	0	4.5	0		
.7	3	2	0	4.8	0		

The data pairs must be entered such that each succeeding x increases in value. About 5 minutes of calculation time is required for this example. Since the data points and coefficients a_n, b_n are stored, the General Function Plot program, III-7, may be used to produce the following plots:

Approximating Fourier Series Plot
Frequency Spectrum of f(t) Plot
Phase Spectrum of f(t) Plot

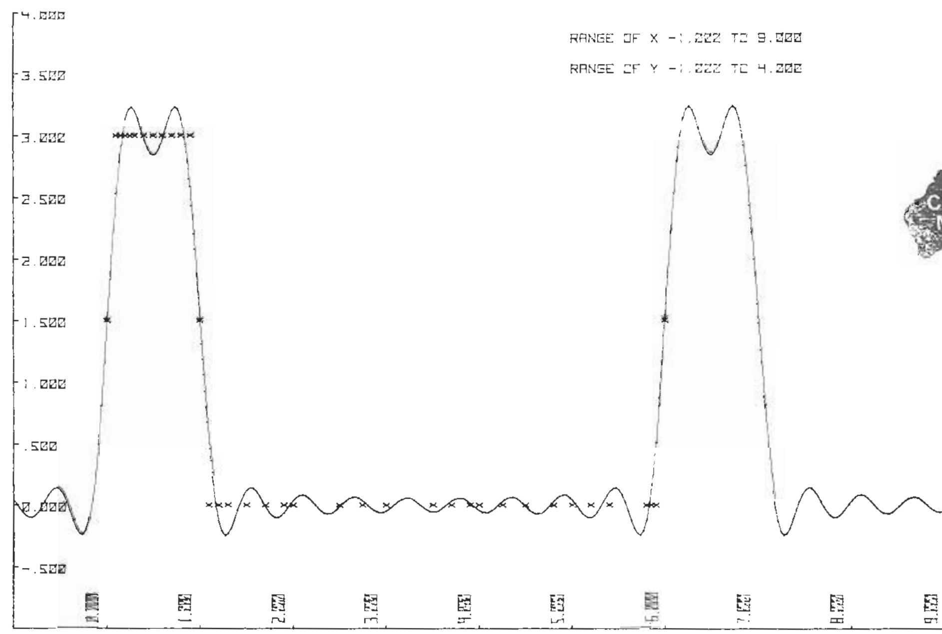
OUTPUT

```
COEFFICIENTS
     N
     AN
     BN

    0.00000000
     .50000000        a0

    1.00000000
     .82623580        a1
     .47682981        b1

    2.00000000
     .41197091        a2
     .71317318        b2

    3.00000000
     .00000000        a3
     .63073598        b3
                      .
    4.00000000        .
    -.20361381        .
     .35201543

    5.00000000
    -.16140575
     .09246861

    6.00000000
     .00000000
    -.00072307

    7.00000000
     .11229009
     .06417231

    8.00000000
     .09651357
     .16664684

    9.00000000
     .00000000
     .19360269

   10.00000000
    -.07365751        a10
     .12756916        b10
```

1. Approximating Fourier Series Plot

Input Data

x_{min} = -1
x_{max} = 9
no. of points = 300
y_{min} = -1
y_{max} = 4



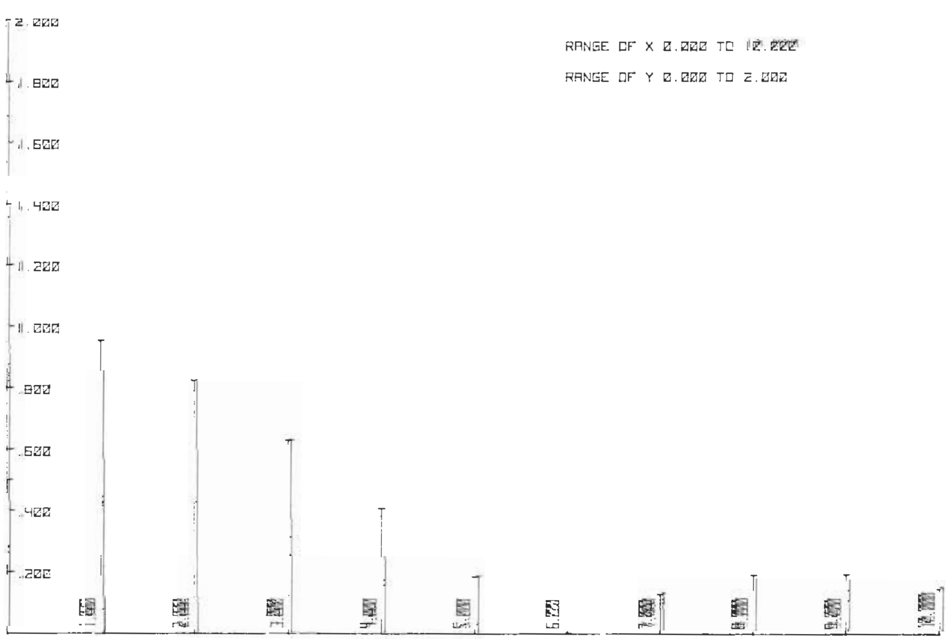
For the next two plots, load the General Function Plot program. Key in the function and the changes for proper x axis labeling.

2. Frequency Spectrum of f(t) Plot

Input Data

x_{min} = 0
x_{max} = n = 10
n = final n specified previously

no. of points = n = 10
y_{min} = 0
y_{max} = 2



√(AN↑2+BN↑2)
0.000
.500
1.000
.954
2.000
.824
3.000
.631
4.000
.407
5.000
.186
6.000
.001
7.000
.129
8.000
.193
9.000
.194
10.000
.147

3. Phase Spectrum of $f(t)$ Plot

Input Data

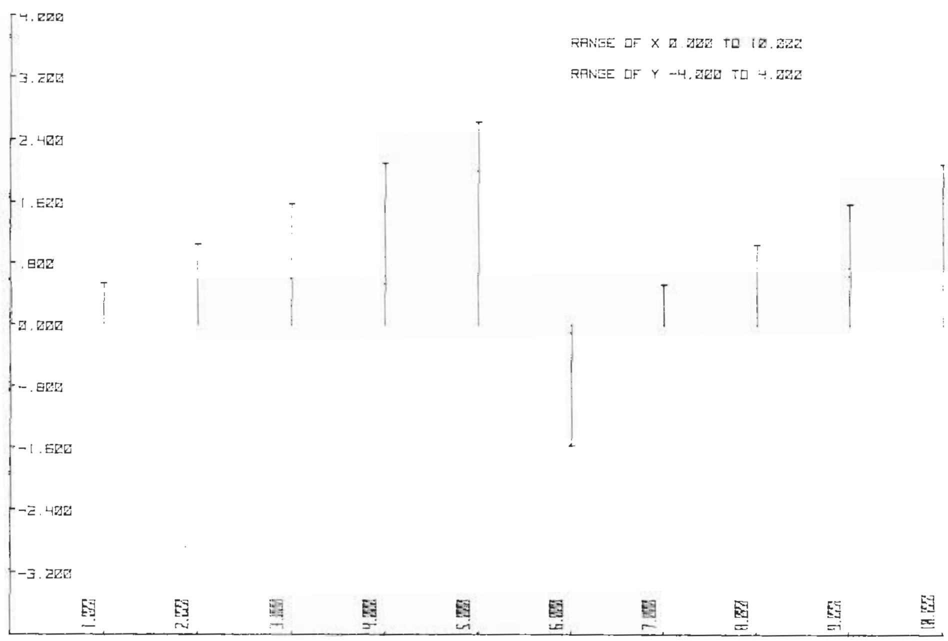
$x_{min} = 0$

$x_{max} = n = 10$

no. of points = n = 10

$y_{min} = -4$

$y_{max} = 4$



ARCTAN BN/AN

1.000	.523
2.000	1.047
3.000	1.571
4.000	2.095
5.000	2.621
6.000	-1.571
7.000	.519
8.000	1.046
9.000	1.571
10.000	2.094

POLYNOMIAL REGRESSION DEGREE ≤ 10 WITH PLOTTER ROM

This program will fit a polynomial model of the form: $y = b_0 + b_1 x \; b_2 x^2 + \ldots + b_k x^k$ where $k \leq 10$ to data points (x_i, y_i), $i = 1, 2, \ldots, n$. The program will plot the data points as they are entered and output all of the important statistics. This program labels axes using the plotter ROM.

Input: User must input the following:

1. Max(x), min(x), max(y), min(y)
2. Increment length for x and y for tic marks on axes
3. Data points (x_i, y_i)
4. Corrections (x_i, y_i)
5. The current degree (k) desired
6. T, the maximum degree to be considered with data set.

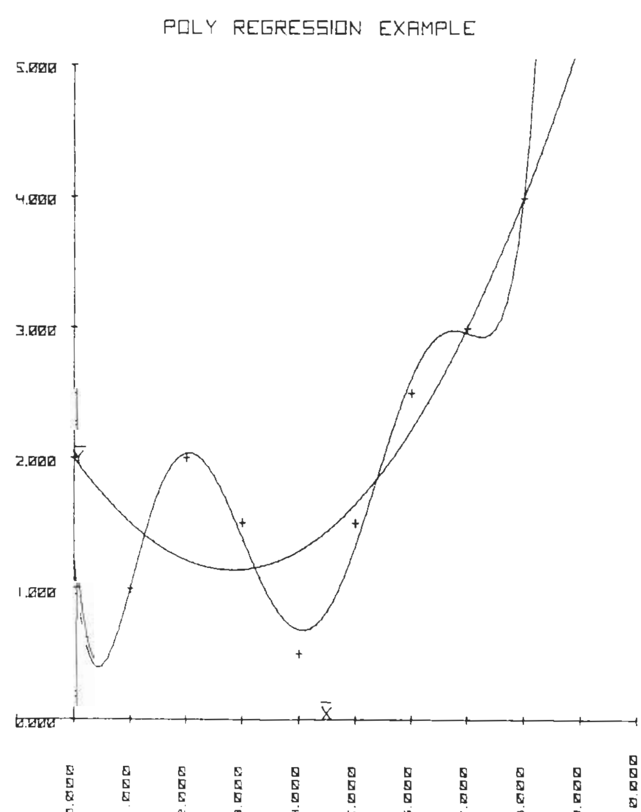
Output

1. (x_i, y_i) and plotted points
2. Means, variances, and standard deviations of x and y
3. An AOV table and R^2
4. Additional SS for each coefficient and partial F test for each coefficient
5. The regression coefficients
6. Plotted line of best fit

The user has the following options:

1. delete incorrectly entered data points
2. calculate different degrees of polynomial regression without reentering data points
3. plot or not plot the calculated regression curves.

A modified Doolittle procedure is used to calculate the analysis of variance and the regression coefficients.

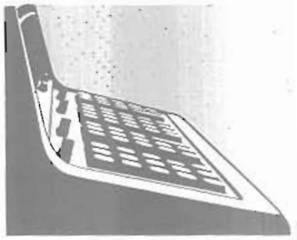


EXAMPLE

```
DEG 10 POLY REG
ENTER
 XMAX→Y
 XMIN→X
           10.000
            0.000
ENTER
 YMAX→Y
 YMIN→Y
            5.000
            0.000
INTERSECT
COOR
 Y→Y
 X→X
INC LENGTH
 Y→Y
 X→X
ENTER
 T→Y
 K→X
            6.000*
            2.000
ENTER DATA
 Y→Y
 X→X
            1.000
            1.000

            2.000
            2.000

            1.500
            3.000

            1.500
            5.000

            3.000
            7.000

            2.500
            6.000

            4.000
            8.000

            0.500
            4.000
===============
DELETE
INCORRECT
DATA
===============
X
 MEAN
 VAR
 ST DEV
            4.500
            6.000
            2.449

Y
 MEAN
 VAR
 ST DEV
            2.000
            1.286
            1.134
```

```
RXY
            0.772
===============
      AOV
SS
 TOT
 MEAN
 TOT ADJ
 REG
 RES
           41.000
           32.000
            9.000
            7.286
            1.714
DF
 TOT
 REG
 RES
            7.000
            2.000
            5.000
MS
 REG
 RES
            3.643
            0.343
===============
FRATIO REG
           10.625
RSQUARE
            0.810
===============
ADD SS
POWER
SS
FRATIO
            1.000
            5.357
           15.625

            2.000
            1.929
            5.625

===============
COEFF
 B0
 .
 .
 BK
            2.000
           -0.607
            0.107
===============
PLOT?
INPUT NEW DEG
      AOV
SS
 TOT
 MEAN
 TOT ADJ
 REG
 RES
           41.000
           32.000
            9.000
            8.906
            0.094
```

```
DF
 TOT
 REG
 RES
            7.000
            6.000
            1.000
MS
 REG
 RES
            1.484
            0.094
===============
FRATIO REG
           15.722
RSQUARE
            0.990
===============
ADD SS
POWER
SS
FRATIO
            1.000
            5.357
           56.746

            2.000
            1.929
           20.428

            3.000
            0.136
            1.444

            4.000
            0.935
            9.905

            5.000
            0.412
            4.365

            6.000
            0.136
            1.444

===============
COEFF
 B0
 .
 .
 BK
            1.250
           -4.522
            7.418
           -4.002
            0.950
           -0.103
            0.004
===============
PLOT?
INPUT NEW DEG
```



CRITICAL SHAFT SPEED AND NATURAL FREQUENCY OF COMPLEX BEAMS

by K. R. Gitchel

PART NO.
09100-72502
9100A/9100B

Cotta Transmission Company designs and manufactures geared transmissions for use in industries ranging from coal mining to aerospace. Some of these transmissions run at speeds exceeding 60,000 RPM. This program was written to provide a quick and inexpensive means of checking high speed shafts for critical speeds. Almost all Cotta high-speed shafts are mounted on ball bearings which are quite stiff compared to journal bearings, so in the program the bearings are considered to be simple supports with a deflection equal to zero and no resistance to tilting.

On many drives, shafts are connected to the drive by flexible joints, and half the weight of the connecting shaft must be concentrated at the shaft end by means of an imaginary disc one half the weight of the connecting shaft. Since this is often the case, gyroscopic moments were left out of the programs, as they would give erroneous results when the weight concentrations are made in this manner. If large and massive discs are attached to the shaft, the absence of gyroscopic moments in the calculations can lead to calculated critical speeds which are so erroneous as to be unusable. In any event, when the program indicates that a critical speed exists within 25% of the operating speed, the shaft is redesigned or a more detailed and lengthy analysis of the shaft is made.

The Prohl method is used in the program.[1]

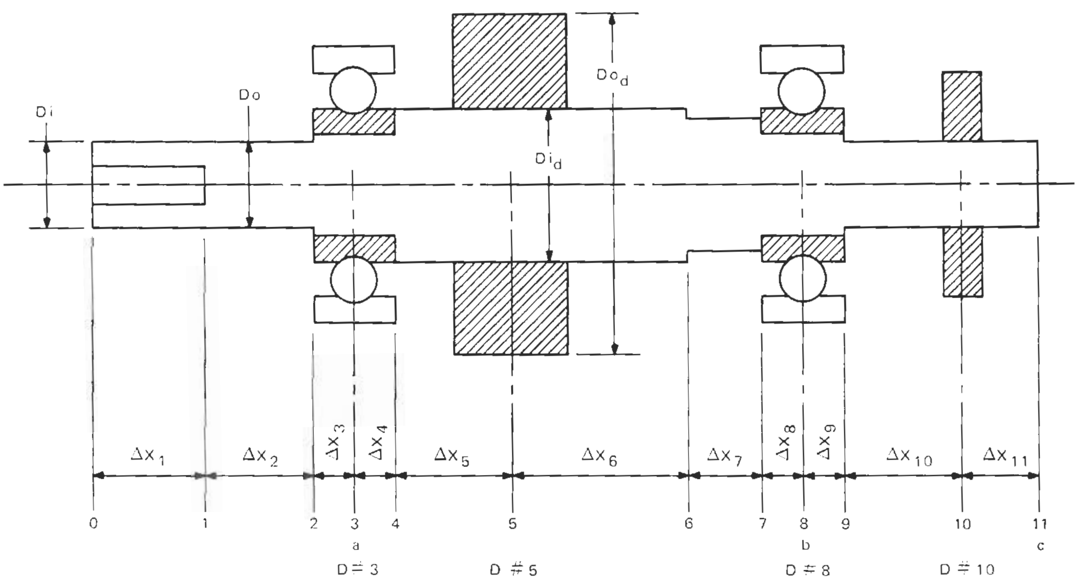


Fig. 1: Shaft Diagram for Critical Speed Calculation

I. CRITICAL SPEED

For critical speed calculations, the shaft must be broken up into sections as in Fig. 1. The shaft must consist of three spans (in the example: 0 to 3, 3 to 8, and 8 to 11). There must be a section taken at both bearings, at all changes in diameter, and at all attachment points of discs. Discs, crosshatched in example, are circular members attached to the shaft which do not contribute stiffness in bending. The bearings are considered simple supports (deflection at bearing is zero; bearing has no resistance to tilting). Gyroscopic moment is NOT included in the calculation. The program increments CPM and calculates excess bending moment at the right hand end (station c). When the excess moment is zero, CPM is a critical speed. All dimensions are in inches, all parts are steel ($E = 29 \times 10^6$, $P_p = .283$ lb/in^3). NOTE: If ΔCPM is too large, some criticals may be missed since the program prints a critical speed when the excess moment goes through zero.

The more sections that are used, the greater will be the accuracy of the result. No attempt should be made to find more critical speeds than half the number of sections. The program will accept up to fifty stations.

Editor's Note: This complete program is available through the Calculator Program Catalog.

TERMINOLOGY FOR CRITICAL SPEED CALCULATIONS

a = station number – left bearing
b = station number – right bearing
c = station number – right end
ΔX_n = length of section n
Do_n = O D of section n
Di_n = I D of section n
Do_d = O D of disc
Di_d = I D of disc
W_d = width of disc
D # = station number of disc
CPM = cycles per minute
ΔCPM = CPM increment
= critical number (1st, 2nd, etc.)

EQUIPMENT NEEDED ☐ 9100A ☒ 9100B ☒ 9120 ☐ 9125 ☐ 9160 ☒ 9101 ☐ 9104 ☐ 9106

☐ DEGREES ☐ RADIANS ☐ FLOATING ☒ FIXED DECIMAL WHEEL AT [3] PRESS ☒ X ☒ Y ☒ Z ON 9120

STEP	USER INSTRUCTIONS	DISPLAY x	DISPLAY y	DISPLAY z
	PROGRAM LOADING			
1.	File Protect Switch OFF			
2.	PRESS: CLEAR, FMT, SET FLAG	0	0	0
3.	ENTER P_0			
4.	PRESS; 0, FMT, FMT	13		
5.	ENTER P_1			
6.	PRESS: 1, FMT, FMT	24		
7.	ENTER P_2			
8.	PRESS: 2, FMT, FMT	27		
9.	ENTER P_3			
10.	PRESS: 3, FMT, FMT	29		
11.	ENTER P_4			
12.	PRESS: 4, FMT, FMT	41		
13.	ENTER P_5			
14.	PRESS: 5, FMT, FMT	54		
15.	File Protect Switch ON			
16.	ENTER CARD 125A, starting at +00			
17.	ENTER Card 125B, starting at –00			
	PROGRAM EXECUTION			
1.	PRESS: CONTINUE	0	0	0
2.	ENTER Data	a	b	c
3.	PRESS: CONTINUE		n	
4.	ENTER Data	ΔX_n		
5.	PRESS: CONTINUE			
6.	Repeat Steps 4 and 5 until all data are entered.	0	n	n
7.	ENTER Data	Di_n	Do_n	

STEP	USER INSTRUCTIONS	DISPLAY		
		x	y	z
8.	PRESS: CONTINUE	0	n+1	n+1
9.	Repeat Steps 7 and 8 until all data are entered. After last continue:	0	0	99
10.	ENTER Data	Di_d	Do_d	D #
11.	PRESS: CONTINUE			99.1
12.	ENTER Data	W_d		
13.	PRESS: CONTINUE			
14.	Repeat Steps 9 through 12 until all data are entered. After last entry PRESS:			
	CONTINUE again:	0	999	999
15.	ENTER number of critical speeds wanted	n_{cs}		
16.	PRESS: CONTINUE	0	0	0
17.	ENTER Data: ΔCPM; CPM Start	CPM_s	ΔCPM	
18.	PRESS: CONTINUE			
19.	Display Flashes	CPM	X_m	0
20.	When critical speed found:	0	CPM	#
21.	If # is last critical speed wanted:	#	#	#
22.	To run new problem, go to PROGRAM LOADING, Step 16.			

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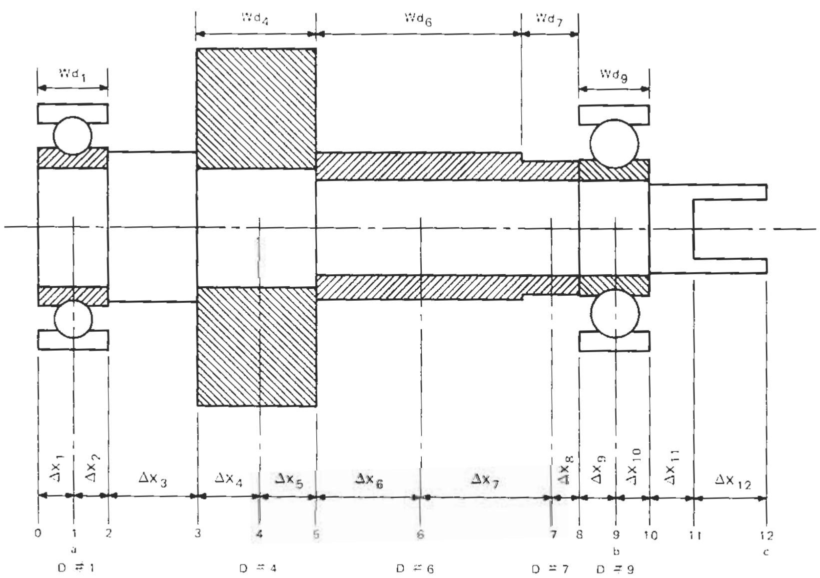
EXAMPLE 1



c = 12
b = 9
a = 1
Δx_1 = .29
Δx_2 = .29
Δx_3 = .75
Δx_4 = .50
Δx_5 = .50
Δx_6 = .87

Δx_7 = 1.12
Δx_8 = .25
Δx_9 = .29
Δx_{10} = .29
Δx_{11} = .38
Δx_{12} = .63
Do_1 = .984
Di_1 = .0

Do_2 = .984
Di_2 = .0
Do_3 = 1.250
Di_3 = .0
Do_4 = 1.000
Di_4 = .0
Do_5 = 1.000
Di_5 = .0

Do_6 = .800
Di_6 = .0
Do_7 = .800
Di_7 = .0
Do_8 = .800
Di_8 = .0
Do_9 = .787
Di_9 = .0

Do_{10} = .787
Di_{10} = .0
Do_{11} = .750
Di_{11} = .0
Do_{12} = .750
Di_{12} = .500
D# = 1
Do_d = 1.312
Di_d = .984
W_d = .58
D # = 4
Do_d = 3.000
Di_d = 1.000
W_d = 1.00
D # = 6
Do_d = 1.250
Di_d = .800
W_d = 1.75
D # = 7
Do_d = 1.125

Di_d = .800
W_d = .50
D # = 9
Do_d = 1.125
Di_d = .787
W_d = .58

No. of critical Speeds wanted = 2

ΔCPM = 1000

CPM Start = 1000

#1
CPM = 85500.000

#2
CPM = 404500.000

Accuracy = ±500

Running time:
15 min — 1st critical
75 min — 2nd critical

Running time depends on shaft configuration

The accuracy of the critical speeds found is ±500 CPM. If better accuracy is desired, proceed as follows. (Example 2)

STEP	USER INSTRUCTIONS	DISPLAY		
		x	y	z
1.	PRESS: GO TO –00			
2.	ENTER Program 125B			
3.	PRESS: GO TO –65, CONTINUE	0	999	999
4.	ENTER number of critical speeds wanted.	2		
5.	PRESS: CONTINUE	0	0	0
6.	ENTER CPM = 100; CPM start = 84900	84900	100	
7.	PRESS: CONTINUE			
8.	Display flashes	CPM	X_m	0
9.	When critical point found, prints CPM and # (Accuracy is ±50 CPM).	0	85050	1
10.	PRESS: CONTINUE			
11.	Display flashes	CPM	X_m	0
12.	PRESS: STOP while display is ON	CPM	X_m	0
13.	ENTER CPM = 403900	403900		
14.	PRESS: CONTINUE			
15.	Display flashes	CPM	X_m	0
16.	When critical speed found, prints CPM and # (Accuracy is ±50 CPM).	0	404950	2

II. NATURAL FREQUENCY OF COMPLEX BEAMS

The natural frequency of stationary complex beams can be found by the same method as critical speeds for rotating shafts, since the basic equations are the same for both. In the program for round shafts, the masses and moments of inertia for the sections and discs were calculated by the program. For non-circular beams, the masses and inertias must be calculated separately and entered in the program.

To convert the critical speed programs to find the natural frequency of beams, some changes in the main program are necessary. These are included in Program Card 125AI, 125BI. The extended memory programs stay the same so that critical speeds of round shafts and natural frequency of beams can be found by using the proper starting card without disturbing the programs in the memory.

The beams are considered to be steel with $E = 29 \times 10^6$. (If a different material is to be used, the value of E must be changed in program steps +c9 to +cc in 125AI.) The attached weights can be of any material.

TERMINOLOGY FOR NATURAL BEAM FREQUENCY CALCULATIONS

a = station number – left bearing

b = station number – right bearing

c = station number – right end

ΔX_n = length of section n

$m'n$ = mass of section (lb-sec²/in²) per inch

I_n = moment of inertia of section (in⁴)

m_w = mass of attached weight (lb-sec²/in)

n_w = station number of weight

CPM = cycles per minute

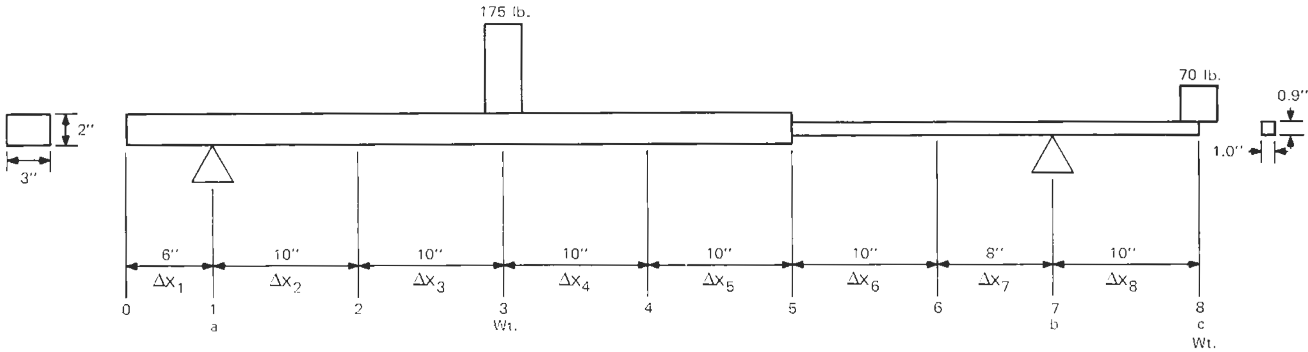
ΔCPM= CPM increment

= Nat. Freq. number (1st, 2nd, etc.)

STEP	USER INSTRUCTIONS	DISPLAY		
		x	y	z
	PROGRAM LOADING			
	Program loading is the same as for Critical Speed except that Card 125AI, 125BI			
	is used in place of 125A, 125B.			
	PROGRAM EXECUTION			
1.	PRESS: END, CONTINUE	0	0	0
2.	ENTER Data	a	b	c
3.	PRESS: CONTINUE	0	n	0
4.	ENTER Data	X_n		
5.	PRESS: CONTINUE	0	n+1	0
6.	Repeat Steps 4 and 5 until all data are entered.	0	n	n
7.	ENTER Data	I_n	m'n	
8.	PRESS: CONTINUE			
9.	Repeat Steps 7 and 8 until all data are entered. After last CONTINUE:	0	0	99
10.	ENTER Data	m_w	n_w	
11.	PRESS: CONTINUE			
12.	Repeat Steps 10 and 11 until all data are entered.			
13.	PRESS: CONTINUE	0	999	999
14.	ENTER number of natural frequencies wanted	n_{nf}		
15.	PRESS: CONTINUE	0	0	0
16.	ENTER Data: CPM; CPM start	CPM_s	CPM	
17.	PRESS: CONTINUE			
18.	Display flashes	CPM	x_m	0
19.	When natural frequency found, prints:	0	CPM	#
20.	If # is last natural frequency wanted:	#	#	#
21.	To run new problem re-enter card 125AI, 125BI and proceed with **Step 1 above.**			

REFERENCE:

1. Prohl, M.A., "A General Method for Calculating Critical Speeds of Flexible Rotors," *J Applied Mechanics*, (Sept., 1945), Trans. A.S.M.E., Vol. 67, p. A-142.



SECTIONS 1 THRU 5:

$$M'n = \frac{(2")(3")(.283 \text{ lb/in}^3)}{386 \text{ in/sec}^2} = .0044 \frac{\text{lb}-\text{sec}^2}{\text{in}^2}$$

$$In = \frac{1}{12}(3")(2")^3 = 2.0 \text{ in}^4$$

$$\text{Wt. at Station \# 3: } Mw = \frac{175 \text{ lb}}{386 \text{ in/sec}^2} = .4534 \frac{\text{lb}-\text{sec}^2}{\text{in}}$$

SECTIONS 6 THRU 8:

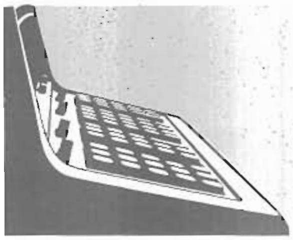
$$M'n = \frac{(1")(.9")(.283 \text{ lb/in}^3)}{386 \text{ in/sec}^2} = .00066 \frac{\text{lb}-\text{sec}^2}{\text{in}^2}$$

$$In = \frac{1}{12}(1")(.9")^3 = .06075 \text{ in}^4$$

$$\text{Wt. at Station \# 8: } Mw = \frac{70 \text{ lb}}{386 \text{ in/sec}^2} = .1813 \frac{\text{lb}-\text{sec}^2}{\text{in}}$$

NATURAL FREQUENCY: 1ST – 625 CPM
2ND – 1375 CPM
3RD – 7225 CPM

K.R. Gitchel is assistant chief engineer for mechanical design for Cotta Transmission Company, Rockford, Illinois. He is a self-taught engineer and has been with Cotta Transmission since March, 1956.



ADDITION AND SUBTRACTION OF OCTAL INTEGERS

by K. Takakubo

PART NO. 09100-70079
9100A/9100B

Many computer dumps are in octal. Debugging such a dump is aided by adding and subtracting positive octal integers.

This program for the HP 9100A or 9100B exactly adds two octal integers of up to ten digits each in the x and y registers, or subtracts (if flag) the integer in the y register:

$$I_3 = I_1 \pm I_2. \quad \text{(in octal)}$$

The result of the operation is displayed in the y register, and another octal integer can immediately be entered for adding to or subtracting from this previous result.

When the input data involves the digit 8 or 9, the program detects one of them, displays an error mark (-9.999 999 999 99) and turns the error lamp on. The display shows which octal integer contains the error, and whether the error is an 8 or a 9 in most cases. In using the library program PART NO. 09100-70012 for this purpose, an error may be introduced because of truncation [see example (3)].

Remarks:

1. Numbers entered must be positive.
2. Only ten-(or less) digit numbers ($1 \leqslant 7\ 777\ 777\ 777 = 8^{10} - 1$) may be entered; otherwise an error may be introduced.
3. For subtraction, $I_1 - I_2$, I_1 must not be less than I_2 ($I_1 \geqslant I_2$).
4. No fraction is permitted. Fractional parts, if any, are added or subtracted decimally and may introduce an error.

EQUIPMENT NEEDED [X] 9100A [X] 9100B [ ] 9120 [ ] 9125 [ ] 9160 [ ] 9101 [ ] 9104 [ ] 9106

[ ] DEGREES [ ] RADIANS [ ] FLOATING [X] FIXED DECIMAL WHEEL AT [0] PRESS [ ][ ][ ] ON 9120

STEP	USER INSTRUCTIONS	DISPLAY x	DISPLAY y	DISPLAY z
1.	ENTER PROGRAM starting at +00			
2.	PRESS END, CONTINUE	0	0	0
3.	ENTER octal integers I_1, I_2	I_2	I_1	
4.	For addition, PRESS CONTINUE.	0	I_3	0
	For subtraction, PRESS SET FLAG, CONTINUE			
	If an error (8 or 9 in I_1 or I_2) is detected, display shows:	-9.99...99	8 or 9	8 or R_1*
	*8 or 9 in the y register identifies the erroneous digit.			
	8 in the z register indicates that the error was found in I_1. R_1 (0, 1, 2, . . . 7) in			
	the z register indicates that the error was found in I_2.			
5.	If no error occurred, return to Step 3 for continued operation.			
	If an error occurred, or for a new case, return to Step 2.			

Editor's Note: This complete program is available through the Calculator Program Catalog.

EXAMPLES

1. 37645312 + 327650 − 4130522 = 34044440
   Enter 37645312 in Y, 327650 in X, CONTINUE.
   Display shows 40175162 in Y.
   Enter 4130522 in X, SET FLAG, CONTINUE.
   Answer 34044440 in Y.

2. Data error: 327682 + 54653
   Enter 327682 in Y, 54653 in X, CONTINUE.
   Error lamp turns on, and display shows:
   8 ——— Z Error in I_1*
   8 ——— Y Error is caused by a digit 8
   -9.999 999 999 99 —— X Error mark.
   *If a data error exists in I_2, the Z register will show a number 0, 1, 2, . . . or 7.

3. 1111111111 + 1 = 1111111112
   HP program 09100-70012 shows an erroneous answer:
   1111111111 + 1 = 1111111111
   This program gives the correct result:
   1111111111 + 1 = 1111111112.

Keiya Takakubo graduated from Tokyo University in 1950. He is a professor of Astronomy at the Astronomical Institute, Tohoku University, Sendai, Japan.

Computer Museum

CALCULATOR PROGRAM CATALOG ADDITIONS

Some of the customer-submitted programs added to the Calculator Program Catalog recently are synopsized here for your information. These programs are not yet listed in the program Catalog. They can be supplied through your local Hewlett-Packard sales office.

Part Number: 09100-70073
Title: Numerical Integration by Gaussian Quadrature
Author: Paul Milnarich, White Sands Missile Range, New Mexico
Equipment Required: 9100A/B, 9101A, 9102A, 9120A
Description: This program uses 26-point Legendre Gaussian numerical quadrature integration to evaluate any definite Reimann integral of a real function, with an accuracy capability of up to 12 significant digits.

Part Number 09100-70074
Title: Matrix Multiplication
Author: A.J. Stevens, A.P.O. Research Laboratories, Melbourne, Australia
Equipment Required: 9100A/B, 9101A, 9102A, 9120A
Description: This program will multipy one matrix by another matrix and produce a printout of the product elements by rows. Each input matrix can have up to 100 elements.

Part Number: 09100-70075
Title: Hermite Polynomial and Function Calculator and Plotter
Author: E. Lane, University of Tennessee, Chattanooga, Tennessee
Equipment Required: 9100A/B, 9125A/B
Description: This program will calculate or plot the Hermite polynomial or the Hermite function or its square for any value of the real variable $|X| < 15.2$ and integer order $n < 70$.

Part Number: 09100-70076
Title: Calculator and Plotter for the Associated Laguerre Polynomial and Related Functions
Author: E. Lane, University of Tennessee, Chattanooga, Tennessee
Equipment Required: 9100B, 9125A/B
Description: This program will calculate or plot the associated Laguerre polynomials or any one of five related functions or their squares for $X < 230$, $m < 70$, and $n < 1981$

Part Number: 09100-70077
Title: Histogram 36 with Gaussian Plot
Author: E. Lane, University of Tennessee, Chattanooga, Tennessee
Equipment Required: 9100B, 9125A/B; 9120A optional
Description: This program will accept a set of real data, calculate the standard deviation, the average, and the number of points, and plot the histogram for 36 cells and the Gaussian approximation curve.

Part Number: 09100-70078
Title: Logarithmic and Linear Diagram Network for the HP 9100B and 9125A/B
Author: R. Bislich
Equipment Required: 9100B, 9125A/B
Description: This program calculates and plots all possible combinations of logarithmic and linear graph grids: (1) X-log, Y-log; (2) X-log, Y-lin; (3) X-lin, Y-log; (4) X-lin, Y-lin.

Part Number: 09100-73207
Title: CELDIM (Cell Dimensions)
Author: R. L. Snyder, State University of New York, Alfred, New York
Equipment Required: 9100B
Description: This program is intended to perform the many routine calculations done in an x-ray crystallography laboratory including those involving the Weissenberg and Precession cameras. Some of the calculations performed are: (1) Cell dimensions from precession data; (2) Cell constants from cone axis data; (3) Cell parameters from Weissenberg data; (4) Cell constants from oscillation data.

Part Number: 09100-76503
Title: Cat and Rat (Tic-Tac-Toe) Game
Author: F. P. Lodzinski
Equipment Required: 9100B, 9101A, 9102A, 9125A/B
Description: This program matches the calculator against the user in a Cat and Rat game. The moves are selected by single digits, and games are plotted by the 9125A/B.

CALCULATOR ART CONTEST

The 1972 Calculator Art Contest for aesthetic designs plotted with any HP 9100 or 9800 system was announced in *KEYBOARD* Vol. 3, No. 4. The rules are repeated here for new *KEYBOARD* readers.

The contest is worldwide, with a general branch and a student branch, with separate winners and prizes for each.

Note: The deadline for submitting entries has been changed. See Rule 9.

Contest Rules

1. Entries may be any aesthetic designs made with an HP calculator and plotter of the 9100 or 9800 series.

2. There is no limit to the number of entries per contestant.

3. Student entries must include student's year in school and name of school or university he attends.

4. Entries must be in either black or red, on plain white paper at least 8 1/2 x 11 inches (21,5 x 28 cm), preferred size, but not larger than 11 x 17 inches (28 x 43 cm).

5. Entries may be in a maximum of two colors. Two-color entries must include one complete two-color plot and a separate plot of each color.

6. Each entry must include a short description of how the plot was made, complete user instructions, a written copy of the program, and either recorded magnetic card(s) or marked cards. *KEYBOARD* will replace the magnetic cards.

7. Entries will become the property of Hewlett-Packard, and cannot be returned.

8. Entries must be mailed either flat with a stiff cardboard protector or in a mailing tube. They may not be folded.

9. Entries may be sent either to the nearest *KEYBOARD* field editor or directly to Loveland. All entries must be received by a field editor not later than Aug. 31, 1972, or by the *KEYBOARD* editor at Loveland not later than Sept. 29, 1972.

10. First, second, and third-place winning entries, and as many others as possible in both the main contest and the student branch, will be published in *KEYBOARD* Vol. 4 No. 3.

PROGRAMMING TIPS

MODEL 20 STORED DATA PRINTOUT

It is often useful to examine the quantities stored in the Model 20's data registers without manually searching through the memory. This short program scans the available memory and prints out only the contents of all data registers that contain non-zero values. The alpha register contents are printed first, followed by the R( ) registers in ascending order through R402.

The program listed here is for the expanded internal memory, either without plug-in ROM's or with the Mathematics ROM. For other ROM and/or memory configurations, lines 8, 9, and 10 may be edited easily to scan all of the available data registers.

This program can be entered to replace the one using the stored data in order to list the data, after which the original program can be reentered with the data still intact. The data can also be recorded on a magnetic card for easy reentry, as shown on p. 5-40 of the Model 20 Operating and Programming Manual.

Instructions

1. END EXECUTE LOAD EXECUTE
2. END RUN
3. Identification of all data storage registers containing non-zero values and their contents are printed.

PROGRAM LISTING

```
0:
PRT " DATA REGIS
TER";"   CONTENT
S"⊢
1:
FLT 9;SPC 2⊢
2:
IF A≠0;PRT "A=";
A⊢
3:
IF B≠0;PRT "B=";
B⊢
4:
IF C≠0;PRT "C=";
C⊢
5:
IF X≠0;PRT "X=";
X⊢
6:
IF Y≠0;PRT "Y=";
Y⊢
7:
IF Z≠0;PRT "Z=";
Z⊢
8:
0→R403⊢
9:
IF RR403≠0;FXD 0
;PRT R403;FLT 9;
PRT RR403⊢
10:
IF (R403+1→R403)
≤402;GTO -1⊢
11:
SPC 8⊢
12:
END ⊢
R398
```

EXAMPLE

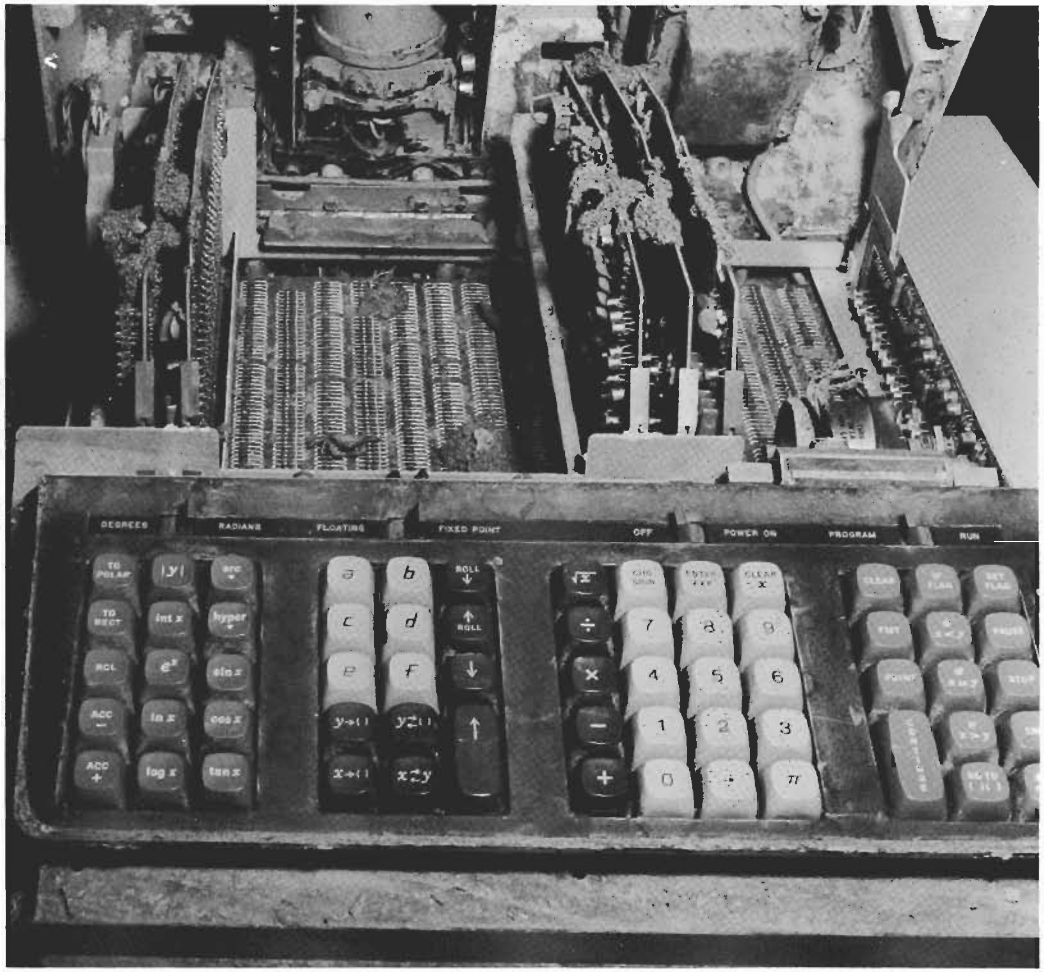
```
 DATA REGISTER
   CONTENTS


A=
-1.414213562E 00
C=
 1.732050808E 00
X=
-8.366600265E-35
Z=
-1.824828759E 00
              21
 2.300000000E-04
             211
 9.800000000E-66
             331
-2.808914381E 01
             402
-3.316624790E 00
```

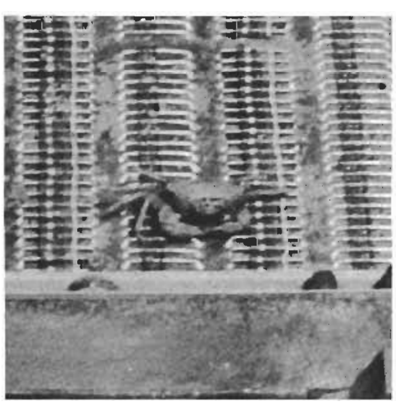
MAGNETIC CARD VERSATILITY

The magnetic cards designed for use with the 9100A/B Calculator can be used to record programs for the Model 10 and Model 20. One side of a 3 5/8 inch (9,2 cm) card, Part No. 9320-1144, will record an average of 225 program steps on each side. Card sides can be recorded sequentially until the Model 10 INSERT CARD light extinguishes, or until NOTE 14 no longer appears in the Model 20 display. Similarly, the 6 inch (15,2 cm) cards, Part No. 9162-0012, for the Model 10 can be used for the Model 20 for short programs.

Use of the 10 1/2 inch (26,7 cm) magnetic cards, Part No. 9162-0045, for recording longer programs on the Model 10 may provide both economy and increased loading and storage convenience.

IT'S THE LITTLE THINGS THAT COUNT





One of the little things you do not normally think about in HP products, since it is not visible and is taken for granted, is the excellence of electromechanical design. Materials and components are selected with sufficient quality as well as electrical derating to withstand unusual environmental conditions and provide a long life expectancy.

A test of this design excellence was made in January 1971 in California, when a Model 9100A Calculator was stolen from Petaluma High School. When the thief was about to be apprehended, he dropped the calculator into the brackish waters of Petaluma slough, where it remained for weeks before a salvage company retrieved it.

The calculator was sent to Loveland for repair. It was full of silt and even contained a small dead crab! But aside from dirt and corrosion, the only thing wrong with the calculator was a blown transistor in the power supply. A thorough cleaning, along with replacement of the transistor and some parts to restore the appearance, restored the 9100A to its original working condition.

Sometimes it takes the unexpected to prove that "It's the little things that count."